desert lands are accomplished. Neither feature is confined to areas which are situated at the mouths of canyons. Both are displayed in bajada belts where rock-floors are present and where the once even surfaces are worn out on the beveled edges of tilted strata. The Calico range, in the Mojave desert, north of Daggett, California, is a notable but not an isolated example. No eminence of the Great Basin region appears, at first glance, to be more certainly a 'lost mountain,' a lofty range buried up to its shoulders in its own debris. The bajadas on either side of the ridge all but meet over its summit. So low and rounded is the crest that manifestly there is no opportunity for extensive outwash around the borders. There is, in this instance, not only remarkable dissection of the bajada belt taking place at the present time but a widening of the apparent lines of drainage into wide flat-bottomed esplanades with deep reentrants. Elsewhere there is the anomaly of a long sinuous terrace several hundreds of feet in height separating the higher general plains-surface from the lower local plains-level. In this we get a glimpse of the formation of those heretofore inexplicable but characteristic desert features known as plateau-plains. In their last stage the isolated Tówa-yal-lané, Acoma and Chupadera mesas, of New Mexico, are conspicuous illustrations. To this phase of the problem attention is later turned.

The feature of desert bajada-terracing, when explained upon a strictly aqueous basis, cannot but lead to complete misinterpretation. The phenomenon has no necessary connection with former and greater stream-activity. It is one of the wide-spread characteristics of desert lands. It is far more largely the result of wind-action than of water-action. Its marvellous aspect is the great rapidity with which it takes form. It is, in reality, one of the subordinate expressions of regional eolation.

RELATION OF THE APEX OF SOLAR MOTION TO PROPER MOTION AND ON THE CAUSE OF THE DIFFERENCES OF ITS POSITION FROM RADIAL VELOCITIES AND PROPER MOTIONS

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Continuing the investigation of the apparent dependence of the position of the solar apex upon proper motion as derived from radial velocities,[1] apices have now been derived from the proper motions

of the same stars which confirm the conclusions from the radial velocities. Solutions were made also from Adams' Mount Wilson list of 500 radial velocities[2] which show the same dependence. This list, however, contains no stars south of $-26°$.

The results from both sets of data are given in table I.

TABLE I

CLASS μ_α	RADIAL VELOCITIES			PROPER MOTION		P. M.—R. V.
	A	D	No. stars	A	D	Δ D
	degrees	*degrees*		*degrees*	*degrees*	*degrees*
2.9 and brighter. All spectral classes	258.0	+41.5	110	258.8	+24.6	−16.9
B	276.0	+29.6	193	272.8	+32.4	+ 2.8
A, F, G						
Large	268.1	+ 8.6	141	261.3	+22.1	+13.5
Medium	269.0	+ 7.0	81	238.5	+50.8	+43.8
Small	254.7	+35.0	277	263.5	+47.4	+12.4
K						
Large	288.7	+18.8	85	255.9	+13.0	− 5.8
Medium	250.4	+15.1	85	258.5	+42.9	+27.8
Small	260.4	+36.8	220	276.4	+69.2	+32.4
Mean	265.7	+24.0		260.7	+37.8	+13.8
Adams' 500 R. V.						
Large	276.9	+ 3.1	47	279.2	+38.4	+35.3
Medium	244.2	+41.6	32	249.6	+50.3	+ 8.7
Small	272.0	+31.6	349	266.4	+67.7	+36.1

These results also show systematic differences between the positions of the apex of the kind noted by Campbell[3] between his apex from 1193 radial velocities and that of Lewis Boss from 4686 proper motions. These discordances are chiefly in declination and are given below according to spectral class in the sense P.M.—R.V.

SPECTRAL CLASS	Δ D	SPECTRAL CLASS	Δ D
	degrees		*degrees*
B	+ 5.3	G	+22.1
A	+13.0	K	+14.7
F	+17.6	M	+ 7.1

There is some indication that the discordance is greater for the later spectral types, at least among the stars with small proper motion in right ascension, and possibly also some relation to magnitude and size of proper motion.

Asymmetry in the proper motions of the B stars and other peculiari-

ties prompted the making of separate solutions from northern and southern stars, the results of which are given in Table II.

TABLE II

PROPER MOTIONS

SPECTRAL CLASS μ_α	NORTH					SOUTH					Δ D
	A	D	X	Y	Z	A	D	X	Y	Z	N−S
		(*all* +)		(*all* +)	(*all* −)		(*all* +)		(*all* +)	(*all* −)	
2.9 and brighter											
All classes....	260°0	26°0	+27.3	155.3	77.1	255°4	21°6	+ 26.6	101.8	41.6	+ 4°4
B............	281.5	46.4	− 3.3	16.3	17.4	269.4	26.2	+ 0.4	34.5	17.0	+20.2
A, F. G											
Large.......	258.0	35.6	+48.0	228.0	167.0	263.7	11.2	+ 39.0	356.0	71.0	+24.4
Medium......	256.3	36.8	+ 6.3	25.8	19.9	227.9	(56.6)	+ 29.8	32.9	67.3	(−19.8)
Small........	262.2	59.4	+ 2.4	17.2	29.4	264.5	40.1	+ 3.2	33.6	28.5	+19.3
K											
Large.......	255.4	17.9	+46.0	178.0	59.0	256.9	3.9	+ 31.0	131.0	9.0	+14.0
Medium.....	269.8	46.4	+ 0.2	58.9	61.8	245.5	35.9	+ 14.6	31.9	25.4	+10.5
Small........	267.6	72.4	+ 0.5	12.2	38.8	282.2	66.2	− 3.2	14.7	34.1	+ 6.2
Mean.........		42.6					32.7				+ 9.6
Omitting ( )...							29.3				+13.8
Adams'500 R.V.											
Large.......	279.8	33.6	−56.0	323.0	218.0	275.8	35.9	− 63.0	626.0	455.0	− 2.3
Medium......	281.9	35.4	− 8.1	38.2	27.7	202.8	18.7	+115.2	48.5	42.2	+16.7
Small.......	279.4	70.7	− 1.2	7.2	20.9	230.9	50.9	+ 6.0	7.4	11.7	+19.8
π Obs. 0″.06											
and over.....	253.7	47.9	+97.0	332.0	383.0	258.0	24.9	+186.0	871.0	414.0	+23.0

These results disclose, if we omit one abnormal southern D, quite consistent differences similar to those between the results from radial velocity and proper motion for all portions of the sky. From these 1194 stars of the spectral classes B, A, F, G and K, the average of the apices from the proper motions of the southern stars agrees closely with the apices from the radial velocities of the same stars, but there is a difference of over 20° for the northern stars, as follows:

	D	
	NORTHERN	SOUTHERN
	degrees	*degrees*
Proper motions..	+43	+29
Radial velocities..	+21	+26
P.M.−R.V..	+22	+ 3

An examination of the rectangular coördinates resulting from the solutions (Table II) shows that nine out of the entire twelve values of Y and all of the values from the small μ_α, are smaller for the northern than for the southern stars, indicating smaller average parallactic displacement for the northern than for the southern stars.

Taking the stars of type B as the best marked example, if we use the value of Y derived from the *southern* stars to determine D for the *northern* stars, we obtain essentially the same D for both northern and southern stars, a value which agrees well with that obtained from the radial velocities of the same stars and with that from the radial velocities of all of the spectral classes. This will be true in principle also for the other cases, but appears to be complicated in the later types by other factors.

Summary.—1. The position of the apex of solar motion depends upon the proper motions in right ascension of the stars used. The differences appear to be greatest in declination, the stars of large proper motion yielding apices south of those from stars with small proper motion. This effect is shown in the results both from proper motions and radial velocities.

2. The differences in D of the apices of solar motion as derived by other investigators from radial velocities and from proper motions are consistent and they appear in general to be greater for the stars of late than for those of early type. This discordance appears to arise chiefly from the proper motions of the northern stars and to be satisfactorily explained by the assumption that the parallactic displacement of the stars is systematically less in the northern sky.

The details of this investigation have been sent to the *Astrophysical Journal.*

[1] These PROCEEDINGS, **2**, 1916, (376–378); *Astroph. J., Chicago, Ill.*, **44**, 1916, (103–116).

[2] *Contrib. Mount Wilson Solar Obs.*, No. 105.

[3] *Berkeley, Lick Obs., Univ. Cal., Bull.*, No. 196, p. 128.

HYDROLOGY OF THE ISTHMUS OF PANAMA

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The Panama Canal being now opened to traffic, there remains for study only one important hydraulic problem—the sufficiency of the available water supply to meet the needs for lockage, for mechanical